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# THE LARVA AND PUPA OF *LYTROSIS PERMAGNARIA* PACK. (GEOMETRIDAE)

David L. Wagner

Department of Ecology and Evolutionary Biology, University of Connecticut, Storrs, Connecticut 06269, USA.
E-mail: david.wagner@uconn.edu

Eric W. Hossler

Department of Ecology and Evolutionary Biology, University of Connecticut, Storrs, Connecticut 06269, USA, and Department of Anatomy and Cell Biology, J.H. Quillen College of Medicine, East Tennessee State University, Johnson City, Tennessee 37614, USA

AND

Fred E. Hossler

Department of Anatomy and Cell Biology, J.H. Quillen College of Medicine,
East Tennessee State University, Johnson City, Tennessee 37614, USA

**ABSTRACT.** Larvae of *Lytrosis permagnaria* were reared to maturity on red oak (*Quercus rubra*). The larva and pupa of this rare eastern geometrid are described and illustrated. Diagnoses and photographic images of late instar larvae are provided for three members of the genus: *Lytrosis permagnaria*, *L. sinuosa*, and *L. unitaria*.

**Additional key words:** *Lytrosis sinuosa*, *Lytrosis unitaria*, *Euchlaena*, twig mimicry.

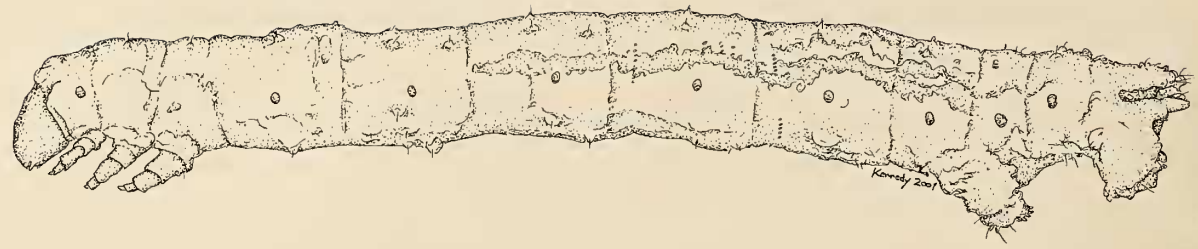
*Lytrosis permagnaria* (Pack.) has been regarded as one of the rarest of eastern macrolepidopterans. At the time Forbes (1948) completed his work on the 'Geometridae of New York and Neighboring States,' the species was known only from the holotype (a female from Missouri). Up until a few years ago there were only two specimens in the United States National Museum. Rindge (1971) characterized it as being "an extremely rare species." Ferguson, an authority on the North American Geometridae, had never seen this species alive before we arranged for him to visit Goshen, Virginia, in 1999. But like so many rare organisms, in the right localities at the right time, *L. permagnaria* can be common. At Goshen we occasionally observed more than a dozen individuals at light on nights in early June. This species is distributed from Georgia to eastern Texas north to Missouri, Indiana, northeastern Tennessee, and central Virginia. Here we describe and illustrate the last instar larva and pupa for the first time, distinguish the larva from congeners, note several morphological similarities in the immature stages of *Lytrosis* and *Euchlaena*, and provide brief observations on the moth's life history.

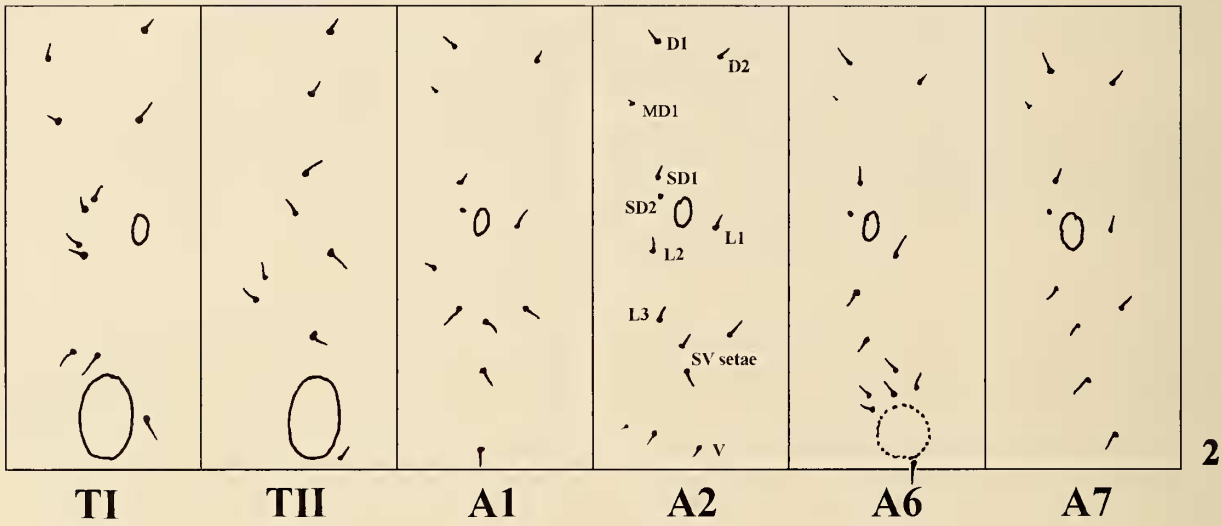
## Methods And Results

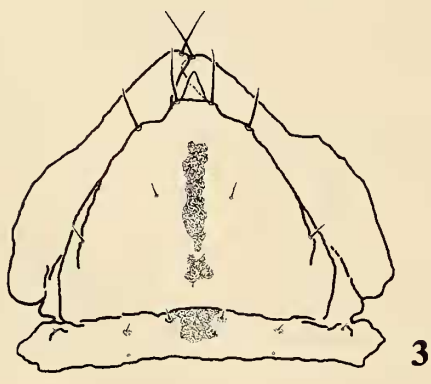
*Lytrosis permagnaria* was seen in the vicinity of the shale pit, southeast of Lake Merriweather, on the property of the Boy Scouts of America Camp, southeast of Goshen, Rockbridge Co., Virginia. A female, collected at light on 9 June 2000, held in a brown paper bag with a wet cotton ball that had been immersed in a solution of sugar and water, began laying pale green eggs after two days in captivity. First instars wander actively, often covering large distances, before settling to feed. Captive 1st instar larvae accepted red (*Quercus rubra*), scrub (*Q. ilicifolia*), and white (*Q. alba*) oaks as well as hickory (*Carya* spp.). The following larval description is based on two pickled larvae (one pre-overwintering caterpillar preserved 29 November 2000 and one mature, post-overwintering caterpillar preserved 17 May 2001) and 58 larval photographs (of three pre-overwintering caterpillars and two post-overwintering caterpillars). The pupa was preserved on 27 May 2001. Adult, larval, and pupal vouchers and slides (transparencies) are deposited at the University of Connecticut.

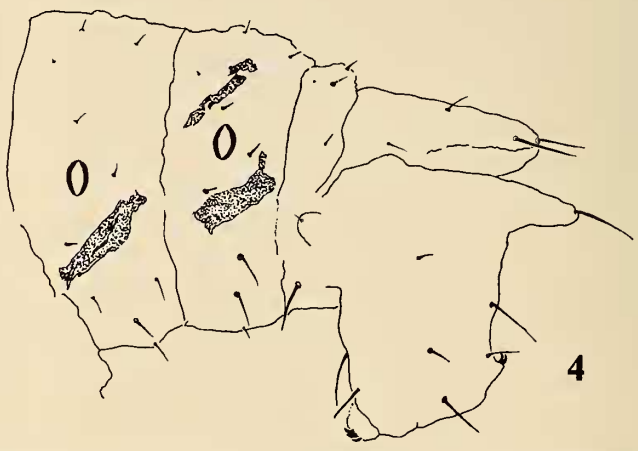
Cranial and body setae of *Lytrosis permagnaria* are very short and inconspicuous. Because we had but two larvae, and a single last instar, our setal mappings must be regarded as tentative. This is particularly true of the cranial setae and minute body setae that were sometimes difficult to locate.

**Description. Last Instar Larva.** Length: 40 mm (probably attaining lengths of 50 mm; n = 1). Head (Figs. 5–11, 14–16, 23) somewhat quadrate, with dark spot at top and pale band down each side of triangle; third stemma enlarged; all setae short, especially P, L, and A setae over dorsum of head (MD setae were not observed). Body (Figs. 1–4, 12, 13). (Note: in our preserved specimens, the posterior half of each segment is enlarged, especially that of A1.) Ground reddish brown in pre-overwintering larvae and smoky gray-brown in mature post-overwintering larvae, fading to tan in alcohol; trunk with numerous brown spots and short undulating, often doubled stripes and broken lines of varied width; integument rough with many shallow pits. Middorsal and subdorsal stripes poorly differentiated; supraspiracular stripe perhaps most evident of all body stripes, especially on A3–A6; midventral and subventral stripes pres-



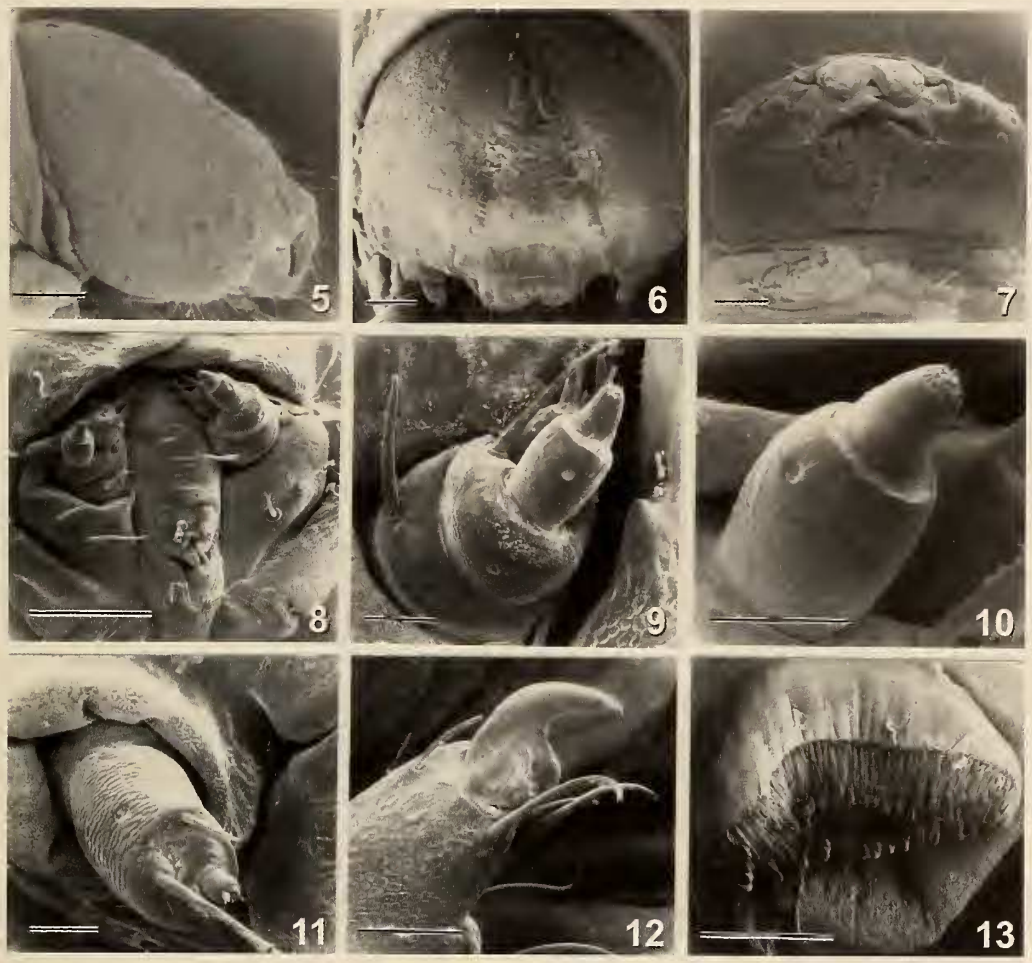



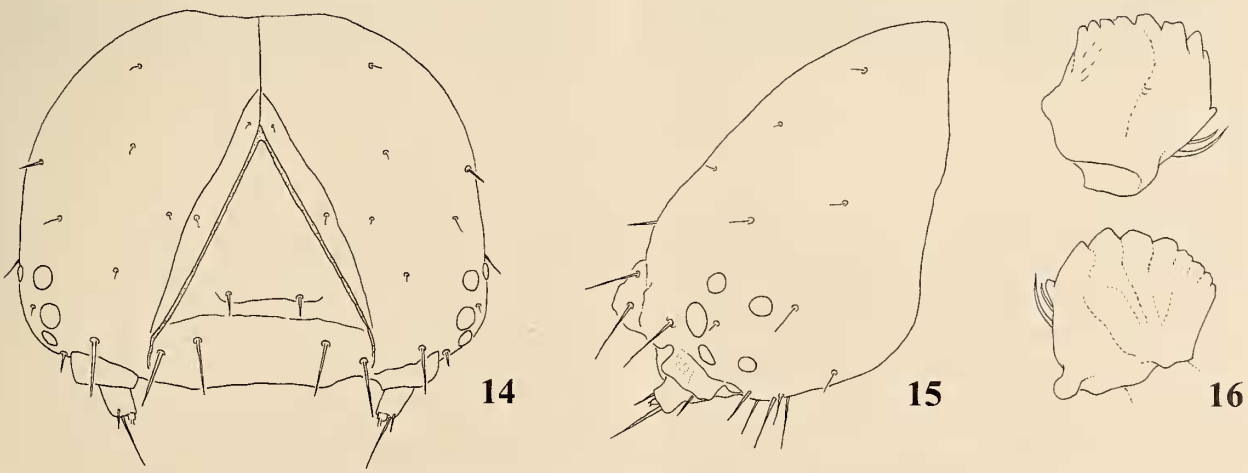




FIGS. 1–4. Last instar larva of *Lytrosis permagnaria*. **1,** Habitus. **2,** Chaetotaxy; setae associated with thoracic legs not shown; $SD_2$ minute and indicated only by its pinaculum. **3,** Dorsal view, A9–A10. **4,** Lateral view, A7–A10.

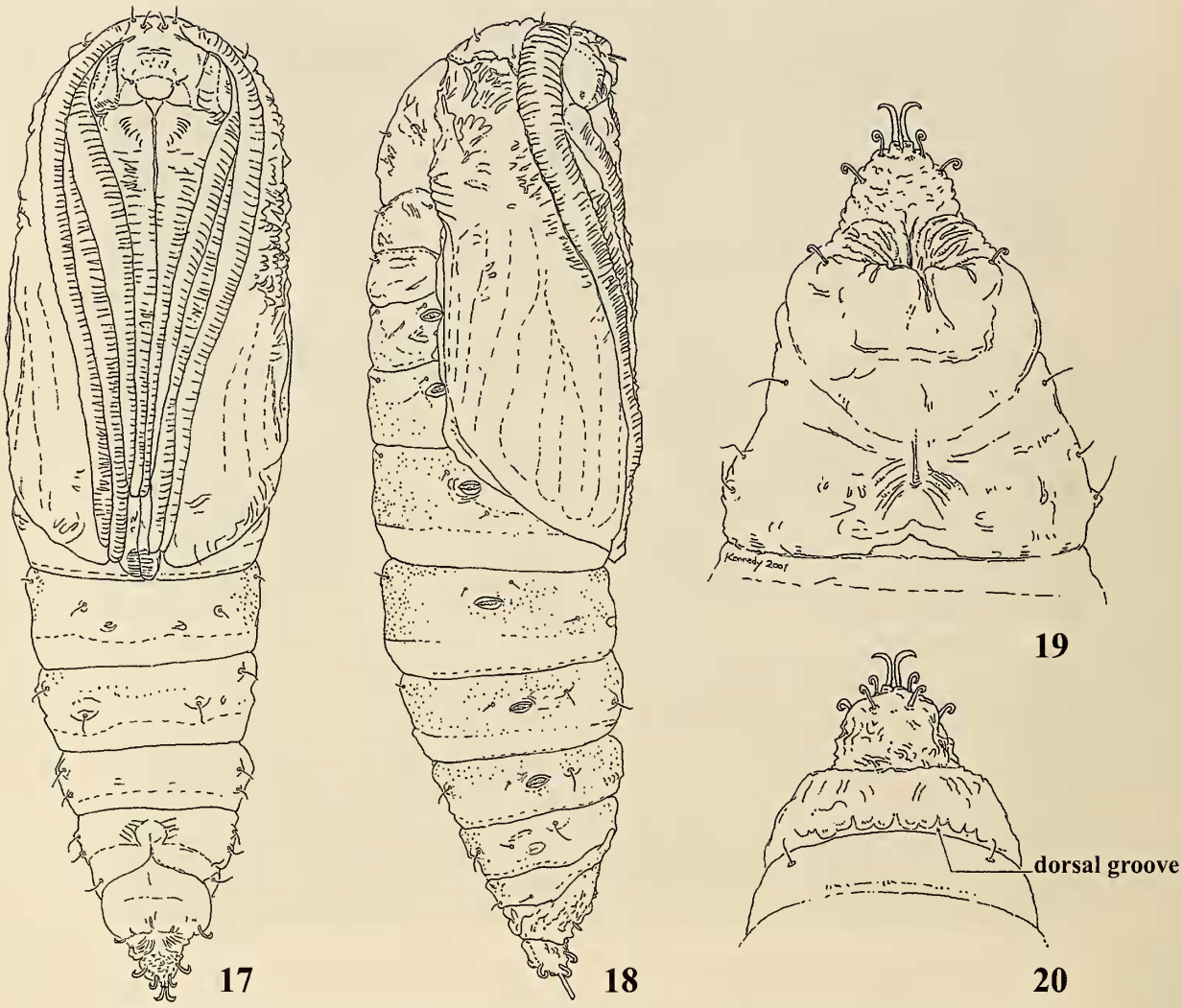
ent on abdominal segments. Most conspicuous markings include black oblique lines on A7 and A8 below each spiracle and small oblique line above spiracle on A8 (which is a continuation of the oblique line that starts on A7). Horizontal black line across anterior proleg. Dorsum of A9 and A10 marked with incomplete middorsal line. Spiracular peritreme thinned dorsad and ventrad; TI and A6–A8 spiracles enlarged, those on A6 and A7 lowered, and that of A8 raised. Anterior face of thoracic legs brown. Crochets: 50–55 on anterior proleg (Fig. 13), 61–66 on anal proleg, mostly of two lengths; intercalated fleshy lobe of Forbes (1948) absent. Hypoproct and paraproct large, latter nearly one-half the length of anal plate and extending well beyond body; hypoproct subequal to paraproct, pointed (Figs. 3, 4, 21). Chaetotaxy (Figs. 2–4): setae brown, short, often less than one-half the height of spiracle on TI. Two SD and




FIGS. 5–13. SEM images of *Lytrosis permagnaria*. **5,** Head, lateral (scale = 500 μm). **6,** Head, dorsofrontal (scale = 500 μm). **7,** Head, ventral, prolegs removed (scale = 500 μm). **8,** Maxillolabial complex (scale = 500 μm). **9,** Maxilla (scale = 100 μm). **10,** Maxillary palpus (scale = 100 μm). **11,** Antenna (scale = 100 μm). **12,** Mesothoracic claw (scale = 200 μm). **13,** Crochets on A6 proleg (scale = 500 μm).




FIGS. 14–16. *Lytrosis permagnaria* head. **14,** Dorsofrontal. **15,** Lateral. **16,** Mandibles.




FIGS. 17–20. Pupa of *Lytrosis permagnaria*. **17,** Ventral. **18,** Lateral. **19,** A8–A10, ventral. **20,** A8–I0, dorsal.

two L setae closely situated on TI. D1 from small wart on A1–A8; D2 on A1 and A5 from small, often yellowed warts (in living individuals). SD2 minute. L1 behind spiracle on A1–A8, but displaced downward on A6; L2 below and cephalad on A1–A8; L3 grouped with SV setae on A1–A2. A6 with five SV setae. SV setae on A7–A9 and all setae on A10 lengthened and paler. L3 and SV setae arising from raised swellings on A7 and A8; A9 with L and SV setae arising from large fleshy warts, SD2 and V extremely reduced. Anal plate with four pairs of setae (Figs. 3, 4).

**Pupa.** Length 20 mm, width 5.5 mm (n = 1; Figs. 17–20). Fusiform, very dark and shiny, deeply rugous over anterior ⅓ of wings and dorsum of thorax and head. Labrum hemispherical, length 0.64 of width. Labial palpus short, tonguelike, nearly as long as wide. Proboscis extending just beyond prothoracic leg. Prothoracic femur not visible. Mesothoracic leg reaching just beyond antenna. Metathoracic leg exceeding mesothoracic leg and wing, reaching anterior margin of A5. Mesothoracic spiracle raised, elongate, undercut posteriad. Length of TIII and A1 subequal. TI–TIII with 2 setae; A1 with 1 seta; A2–A3 with 2; A4 with 3; A5–A6 with 4, SV on pronounced swelling; A7–A8 with 3 setae; A9 with 2 setae and dark pit cephalad of L seta. A10 cremaster consisting of 4 thickened, recurved pairs of setae and one enlarged pair of caudal hooks (Figs. 19–20).

## DISCUSSION

All *Lytrosis* caterpillars are twig mimics (Figs. 21–26). This is most apparent in *Lytrosis sinuosa* whose texture, coloration, and patterning closely resembles that of a *Quercus* (especially a white oak) twig (Figs. 24–25; Wagner et al. 2002). It is believed that middle instar *Lytrosis* larvae spend the winter exposed on bark—two of three *Lytrosis permagnaria* that we sleeved on *Quercus rubra* in October 2000, survived the winter in eastern Tennessee (Johnston City). McGuffin (1981) stated that *Lytrosis unitaria* overwinters as a 5th instar. In the same work, McGuffin reported that *L. unitaria* has up to 9 instars—the largest number for any geometrid of which we are aware.

There are four species of *Lytrosis* in eastern United States (Rindge 1971, Ferguson 1983), only one of which, *Lytrosis unitaria* (H.-S.) is widespread and com-


FIGS. 21–26. Larvae of *Lytrosis*. **21,** *Lytrosis permagnaria*, overwintering larva. **22,** *Lytrosis permagnaria*, mature larva. **23,** *Lytrosis permagnaria*, mature larva, head. **24,** *Lytrosis sinuosa*, overwintering larva. **25,** *Lytrosis sinuosa*, mature larva. **26,** *Lytrosis unitaria*, mature larva.

mon. The three others are scarce or only locally common. Two of the four, *Lytrosis heitzmanorum* Rindge and *L. sinuosa* Rindge, were not described until 1971—which is remarkable in that *Lytrosis* are among the largest eastern geometers, with wingspans exceeding 5 cm. Larvae are known for three of these. In *Lytrosis unitaria* the D2 setae arise from a transverse ridge on A1 that is less than one-fourth the segment length and A5 has conical projections that bear the D2 setae. In *Lytrosis sinuosa* the D2 setae arise from grossly enlarged subdorsal swellings on A1 and enormous subdorsal swellings on A5; in addition there are subventral swellings on A2. In *Lytrosis permagnaria* the D2 setae on A1 and A5 arise from small, often orange-yellow warts; the body lacks conspicuous ridges or swellings.

The immature stages of *Lytrosis* share several similarities with members of the genus *Euchlaena*. Common features include the D2 setae arising from warts or ridges on A1 and A5; the black prespiracular dashes, best developed anterior to the spiracle on A4–A6; the

presence of 5 SV setae on A6; the black horizontal line on the anterior proleg; the humped dorsum of A8; and, according to McGuffin (1981), a similar pupal callosity (=mesothoracic spiracle). Larvae of the two genera may be distinguished as follows: the crochets number >50 in *Lytrosis*; there are oblique (black) lines on A7 (below spiracle) and A8 (above and below spiracle) that are more apparent in *Lytrosis* than any of the *Euchlaena* that we have examined (six eastern species); the D setae are approximately one-half of the spiracular height (in *Euchlaena* the D setae are subequal to the spiracular height); and lastly, both the paraprocts and anal proleg are proportionately larger in *Lytrosis*. The close pairing of the two SD setae and the proximate grouping of the L setae on TI also may be diagnostic for *Lytrosis*. This condition does not occur in *Euchlaena marginaria* (Minot) (McGuffin 1981) *or Euchlaena serrata* (Drury) (DLW specimens).

Rindge (1971) noted that adults of *Lytrosis permagnaria* possessed the most primitive features of any of the four members in the genus: i.e., the male has a metatibial hairpencil and the vesica has separate spines that are exerted on the right, anterior to the apex of the aedeagus. The unremarkable larval morphology of *L. permagnaria* supports Rindge's position—its body is unwarted and more closely resembles that of a *Euchlaena* than either *L. unitaria* or *L. sinuosa* (Figs. 21–26).

Given *Lytrosis permagnaria*'s overall scarcity in the East, we are puzzled by its abundance at Goshen, Virginia. Nothing impresses us as exceptional about the locality and indeed we probably would have passed on blacklighting at the site, had we not known that *L. permagnaria* had been collected along the road in previous years. The Goshen colony strikes us as undistinguished botanically; woody plants growing in the vicinity of our sheets and traps include *Acer rubrum*, *Amelanchier* sp., *Carya* sp., *Cornus* sp., *Nyssa sylvatica*, *Platanus occidentalis*, *Quercus rubra*, *Quercus alba*, *Sassafras albidum*, and *Tsuga canadensis*. Both *Lytrosis unitaria* and *L. sinousa* fly with *L. permagnaria* at Goshen during early June. J. R. Heitzman (pers. com.) informs us that all four *Lytrosis* species may fly sympatrically in the Ozarks.

*Lytrosis permagnaria* has been reported to be locally common in northeastern Georgia by James Adams and in Cheaha State Park, Alabama by Tim McCabe. Both of these localities and Goshen are low elevation or foothill Appalachian forests—to the best of our understanding, no unusual plant is common to the three sites. In captivity *L. permagnaria* larvae accepted *Quercus alba*, *Q. ilicifolia*, *Q. rubra*, and a *Carya* species. Survivorship was higher on *Querucs*, perhaps because picked oak foliage holds up longer. *Lytrosis unitaria*, the best known member of the genus, has been recorded from *Acer*, *Amelanchier*, *Crataegus*, *Pinus strobus*, *Prunus*, *Quercus*, *Rosa*, and *Vaccinium* (McGuffin 1981, Wagner et al. 2002, DLW unpublished data). Wild hosts are unknown for *Lytrosis sinuosa*, but captive individuals have been reared from both *Acer negundo* and *Quercus* (Wagner et al. 2002). Host data for the related, and more well studied genus, *Euchlaena*, indicate that its members are widely polyphagous on woody plants (McGuffin 1981, Handfield 1999, Wagner et al. 2002). It seems unlikely that the moth's scarcity will be explained by an unusual host association—we leave it to others to discover why such a widespread, unspecialized feeder, remains one of the East's rarest moths.

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## LITERATURE CITED

FERGUSON, D. C. 1983. Geometridae, pp. 88–107. *In* Hodges, R. W. et al. (ed.), Check list of the Lepidoptera of America north of Mexico. E. W. Classey Ltd. and The Wedge Entomolgical Research Foundation. Cambridge Univ. Press, Cambridge, United Kingdom.

FORBES, W. T. M. 1948. The Lepidoptera of New York and neighboring states. II. Geometridae, Sphingidae, Notodontidae, Lymantriidae. Memoir 274. Cornell University Agricultural Experiment Station, Ithaca, New York. 263 pp.

HANDFIELD, L. 1999. Le guide des papillons du Québec. Broquet Inc., Boucherville, Quebec, Canada, 982 pp.

MCGUFFIN, W. C. 1981. Guide to the Geometridae of Canada (Lepidoptera). III. Subfamily Ennominae, 3. Memoirs of the Entomological Society of Canada No. 117. 153 pp.

RINDGE, F. 1971. A revision of the moth genus *Lytrosis* (Lepidoptera, Geometridae). American Museum Novitates 2474. 21 pp.

WAGNER, D. L., D. C. FERGUSON, T. L. MCCABE & R. C. REARDON. 2002. Geometroid caterpillars of northeastern and Appalachian forests. USFS Technology Transfer Bulletin, FHTET-2001-10. 239 pp.

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